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East Europe Report

SCIENTIFIC AFFAIRS

No. 705

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FUNDS ESTABLISHED TO ENCOURAGE INNOVATION, DEVELOPMENT

Budapest MAGYAR HIRLAP in Hungarian 25 Apr 81 p 7

[Article, with interviews, by Istvan Matko: "It Is Not Enough to Invent"]

[Text] According to a study prepared by the International Institute of Applied Systems Analysis (IIASA)--it is located in Laxenburg, Austria--accelerating progress in science and technology has increased the rate of technological change and shortened the average life of technological generations, now merely 6 to 8 years in the industrially developed countries. In the next 20 years the average life of a technological generation will probably be shortened further.

The magic word "innovation" requires ever less clarification. For this comprehensive activity has practically become the star of not only research and development, but also of the subsequent phase of industrial realization: of production and marketing as well.

In any case, an example will be in order. In the development of the bubble memory (a sensational new invention in the field of data storage) Hungary has almost caught up with the world's most advanced industrial powers. By the early 1980s we, too, have a bubble memory--as a product of intellectual effort--and even several experimental models of such a memory. It is typical that the United States, Japan, England and the Philips Company can boast of similar results, while even West Germany has decided to obtain a license for a bubble memory, instead of developing one of its own.

Bubble Could Burst

Unfortunately, this enormous scientific success could easily burst like a bubble in our hand, for the practical realization of this scientific result --its industrial application--appears very remote in Hungary for the time being.

The situation is quite different in the mentioned industrially advanced countries where industrially produced bubble memories already are availab , and their application is advancing rapidly. Why is this so? Because in

industrial realization and application these countries already have an innovation practice, organization and incentive system that make them capable of accomplishing this.

There can hardly be any doubt that the economy's ability to compete depends in the final outcome on innovation capability. In our series of articles, which we have prepared jointly with "The Week" program on television, we sought answers to the question as to how innovation could be speeded up in Hungary.

Let us start with the central measures, and preferably with the most important ones among them. Within the Council of Ministers the Committee on Science Policy is aiding the unfolding and development of economic innovation capability in numerous ways. In 1979, for example, it published recommendations on developing the protection of industrial property at the enterprises, and these recommendations covered also innovation. The document established that in Hungary the protection of industrial property has not yet become an integral part of economic and technological development. Therefore it instructed the economic organs, institutions, etc. to define the tasks in conjunction with the protection of industrial property, to formulate comprehensive guidelines for these tasks, to promote the transfer of scientific and technological results, and to elaborate the organizational prerequisites for this. The TPB [Committee on Science Policy] also issued suitable directives on this, for the ministries as well as for nonministerial organs. It emphasized that research and development activity at the enterprises--the development of products that satisfy the attribute of novelty--is an essential condition for the production structure's modernization. Therefore the enterprises must elaborate and employ competitions, assignments, incentive systems, etc. that generally promote the development of invention-level products, the creation of an attitude that encourages innovation efforts.

Among other things, the Committee on Science Policy also called attention to the fact that inventions by employees are socialist property, and that economic organizations must exercise their rights to such inventions and not waive them.

Joint Risk

Implementation of the directives and resolutions began, but the competent organs were not satisfied with the rate of progress. At the beginning of 1980, specifically to promote innovation activity, the Committee on Science Policy proposed the stablishment of a special risk fund in Hungary. This organization was finally formed within the Hungarian National Bank, with a credit limit of 600 million forints. It was assigned the task of aiding the realization and marketing of new intellectual products.

As Innovation Fund manager Erzsebet Birmann told us, this organization does not function simply as some new source of credit, rather it itself is a partner in the ventures.

[MAGYAR HIRLAP] What exactly does this mean?

[Birmann] It means that when enterprises, cooperatives or individuals come to us with their ideas, we examine these ideas from the viewpoint of a partner: will it be worth our while to handle the proposal? Naturally, it also means that we will share in the profits, commensurately with the risk we take. We adopted this method, or rather the functional model of the Innovation Fund, from the Innowa Wien Company of Vienna.

Question of Interest Unresolved

[MAGYAR HIRLAP] Has the first year of operation been sufficient time to bring a few ventures to fruition?

[Birmann] We are coping with numerous difficulties, and I will be dwelling on them briefly also in my interview on "The Week" program. Among other things, our main problem is that we do not have suitable organizations and enough qualified experts to construct the inventions, and also the question of interest is unresolved. However, one or two of our ventures are close to fruition.

One venture of the Innovation Fund will be the new logic game that hopefully will duplicate the world success of the magic cube. Four inventors of the FOK-GYEM [expansion unknown] Cooperative--Sandor Jodal, Jozsef Mandzsu, Gabor Sumegi and Endre Papp--developed it from a mechanism that originally served an entirely different purpose.

Endre Papp: We filed our patent application in 1980, and by now we have already concluded a 4.5-million-dollar supply contract with an American company, Toy Ideal. We plan to start production immediately after buying the machinery. For this we have used the financial assistance of the Innovation Fund and also of SKALA-COOP [expansion unknown].

Gyorgy Darvas, director general of GENERALIMPEX [expansion unkown]: The prospects are good for substantial continuous sales of games. We plan to sell annually more than 10 million dollars' worth of the Tower of Babel and its variants. This product is very promising also from our point of view.

SKALA's Efforts

Demonstrating its intention to provide initiative and willing to assume the risk of accepting a share of the total profit, the SKALA-COOP also joined the organizations that aid the innovation process. Gabor Renyi, the director of the office, informed us of all this as follows.

[Renyi] Our office was formed on 1 January as a department of SKALA. The puprose of our office is to aid the realization of new products, exploration of the domestic and foreign markets, and the marketing of the products. We have attempted to do this with several products. For example,

we have a financial interest in FOK-GYEM's new family of games. Another invention is a unique process for casting aluminum. It was purchased by five companies from inventor Tibor Jenei, respectively from the partnership that he formed to market his invention. We are handling also the Aerozom invention that is intended to replace the familiar aerosol cans; or more accurately, it uses a new propellant that does not harm the earth's ozone layer.

Few Exceptions

The fact remains that encouragement of the innovation process cannot be narrowed down to the functioning of the Innovation Fund or to the efforts of SKALA. The process itself is interlinked with the economy, with the entire system of research and development, and therefore it would be difficult to single out anything within it. But it is undeniable, and experts unanimously agree, that there are few Hungarian products which could serve as a model of a rapidly functioning innovation process. There are few "large shops" which could manage, and inspire with sufficient speed, the process--from invention to realization. Among the few exceptions we can cite the United Incandescent Lamp Company Ltd, within which every element of innovation has been provided, and all elements are functioning suitably. Likewise good--at least by Hungarian standards--is Chinoin's product manager system, or the several closed innovation loops of the Babolna combine. The Taurus Rubber Industry Enterprise likewise belongs among the exceptions. There a hose was developed for deep drilling in the petroleum industry, and it is regarded as the standard also in the United States! Taurus not only developed the hose, but since then it has been also producing it economically, in series.

However, we cannot be satisfied with the rate of innovation in Hungary. Our article tomorrow will discuss this problem, and the prospects of further progress. Readers can gain an insight into the state of innovation at home and abroad not only from our series of articles, but also from "The Week" program on television tomorrow, April 26th.

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HUNGARIAN PARTICIPATION IN SPACE RESEARCH

Budapest FINOMMECHANIKA MIKROTECHNIKA in Hungarian Vol 20 No 1, Jan 81 pp 1-10

[Article by Dr Csaba Ferencz, graduate electrical engineer, candidate of engineering sciences, Interkozmos Council of the MTA (Hungarian Academy of Sciences). This article was also published in HADITECHNIKAI SZEMLE, in Hungarian, No 3, 1980. The author was awarded the gold medal of the Merit of Labor on 6 August 1980 by the Presidential Council in recognition of his work performed in connection with the preparation of the scientific program of astronautics.]

[Excerpt] The proposal of the USSR in 1965 to establish a joint space research program among the socialist countries opened up qualitatively new, broad possibilities. It gave a realistic possibility for direct participation in experiments with satellites and rockets since the generosity of the proposal provided that we must pay only the direct expenses of our own work and not the proportional share of the full costs of the projects involved. During 1966 and 1967 we organized and prepared the significantly changed and enlarged space research activity. A Governmental Committee on Space Research was established to guide the work aimed at the peaceful study and utilization of outer space. The Governmental Committee on Space Research carried on until 1978, when it was disbanded. National coordination and guidance of all space research in Hungary has been the task of the Interkozmos Council of the Hungarian Academy of Sciences since 1979.

Active Participation

We started to participate actively in actual scientific programs during 1967-1968 at a level corresponding to the scientific and engineering

capabilities and financial limitations. Our experts have participated from the beginning in every major space-research activity. For example, since 1967-1968 they work in cosmic physics, cosmic meteorology, space communications, and medicine/biology. Since 1975, they joined the work of Interkozmos in the new joint energy-resource search project (remote sensing of earth by aerial and space reconnaissance). A major advancement came in the utilization of the achievements of space research when the Intersputnik International Space Communications Organization was established in late 1971.

Initially we participated in the activities of Interkozmos by studies on earlier ground-based instruments (satellite tracking and so forth) and in laboratories. We developed these studies further and contributed according to our capabilities. At the same time, we also started the development of space-electronic devices and other instruments, equipment, and devices for use on board of satellites and high-altitude rockets launched within the Interkozmos program. The major trend of the developments during the last 10 years was that experiments carried out aboard space vehicles gradually became more important and ultimately predominated. Of course, terrestrial and laboratory studies continued and formed part of complex programs such as projects related to the sojourn of humans in outer space. Another important feature of these complex studies was that most involved cooperation with socialist partners in most areas. These research and development activities contributed to the fact that major achievements also resulted in many theoretical studies.

It was always our major goal in designing our work to make most profitable use of the results of space studies in the national economy. Within a short period of time, space research became a fundamental and indispensable mainstay of our civilization. Without communication, meteorological, navigational, geodetic and surveying, energy-resource seeking, ocean-surveying, global heat-balance examining and similar satellite systems, we could not maintain our technical civilization. Further developments make the usefulness of space technology even more spectacular. The Hungarian experts have kept in mind the fast exploitation of the potentialities of space research in recent years.

The year 1976 featured a major growth of the Interkozmos program. Interkozmos obtained a broader base, as the needs grew, by the conclusion of a new agreement providing for joint space flights and the start of the training of socialist cosmonauts for participation in the Soyuz-Salyut space program.

We shall discuss the actual experiments and accomplishments in more detail. But some accomplishments deserve special mention. Since 1968, we can receive the cloud-picture transmissions of meteorological satellites on a continuous basis, and we provide a service which permits the immediate viewing of the pictures by airline pilots at Budapest-Ferihegy international airport. During 1972-1973, we developed a radiation-biological phantom which is the tissue-equivalent of a standard European human, and we can now manufacture the phantom in series. The phantom is used in space research, as well as in general radiotherapy, medical therapy, and research. The first Hungarian-built electronic device has successfully flown aboard Interkozmos-12 in 1974. This achievement -- which included technological developments -- was the start of our many projects aimed at the development of space-vehicle instruments. The Hungarian Intersputnik ground station was started up in 1977 at Taliandorogd. In the course of the realization of the space-research program, we developed many items which the institutions involved can use not only in connection with the utilization of the results of space studies in the national economy but also in many other fields and in the solution of everyday problems. It is also worthy of note that space-related activities involve not merely the natural sciences. We also examine -- albeit only sporadically -- the effects of space research on society and civilization, with special emphasis on the solution of civilizational problems and productivity.

Cosmic Physics

Hungary has participated from the beginning in the realization of the programs of the Permanent Physics Working Group of Interkozmos. All institutions involved in the study of the higher strata of the terrestrial atmosphere, the relationships between the earth and the sun, and the observation of satellites participate in the work. Thus, continuous work is being carried on in the field of cosmic physics at the Astronomical Institute of the Hungarian Academy of Sciences, the Geodetics and Geophysics Research Institute of the Hungarian Academy of Sciences, the Central Physics Research Institute of the Hungarian Academy of Sciences, Eotvos Lorand University of Sciences, Budapest Technical University, Hungarian Geodetic Service, and the Eotvos Lorand Geophysical Institute.

The instruments and equipment required for the studies was also developed and made at these institutions. Many highly reliable components and parts made by the Hungarian industry were used in the development. Thus, Hungarian enterprises such as Remix, Tungsram, Kobanya Porcelain Works, and others handled themselves well in their contribution to Hungarian cosmic-physics research, culminating in the use of equipment aboard satellites.

Upper-Atmosphere and Magnetosphere Studies

Phenomena occurring in the upper atmosphere have traditionally been studied in Hungary by other than space-related devices. Thus, as soon as the space studies have started, we immediately started to use space-related equipment for investigating the dynamic processes taking place in the upper atmosphere. We carried out intensified terrestrial measurements while Interkozmos satellites designed to study the ionosphere were in orbit. The first results in this field were obtained by a complex scientific analysis of ground-based and satellite-based measurements.

As the on-board electronic systems became perfected in engineering and technological terms, we conducted a joint Soviet-Hungarian instrument-development program for the investigation of the extreme ultraviolet radiation of the sun and the effects of this radiation on the upper atmosphere. The first LAM-1 and LAM-2 instruments have flown in 1977 aboard the Vertikal-6 geophysical rocket. The raw data obtained have been analyzed scientifically. Since then, we have repeated the experiment in 1978, aboard the Vertikal-7 geophysical rocket. Presently we plan to continue the experiments aboard rockets and satellites.

Similarly and closely related to the above, we participated from the very beginning in studies of the magnetosphere. It this area too, we started to participate by using ground-based observers for space studies. Later we joined the processing and evaluation of data obtained on the magnetosphere from Soviet Prognoz satellites.

In addition, we participated in the work by means of VLF whistler observations, which are practically traditional in Hungary. A new scientific achievement in these studies was that we were the first to develop the effective computer-assisted processing of the many data generated by the registered whistlers. This permitted the continuous monitoring of the status of the magnetosphere on the ground (over the USSR, Czechoslovakia, Hungary, and so forth) and in space (Interkozmos-13 satellite and so forth), using the data obtained from both sources simultaneously.

Investigation of the Interplanetary Space

On the basis of the results of studies on satellite radio signal propagation and Doppler measurements, we succeded in developing the unified interpretation of the irregular wave-propagation phenomena in the solar system, primarily in the vicinity of the sun.

Since 1971/1972, we participate in the processing and scientific interpretation of the data generated by Prognoz satellites concerning the interplanetary space. In connection with this, we carried out studies on the solar wind, and we are investigating the structure of the interplanetary space. A major advancement in this area was the launch of the LAM-3 instrument aboard the Prognoz-7 satellite — which was part of the Plazmag experiment — where the small computer of the instrument performed the preprocessing of the data aboard the satellite.

Hungarian researchers also participated in the scientific processing and evaluation of the data generated by Soviet-made Venera rockets aimed at the study of Venus. On the basis of data from the Venera-9 and Venera-10 space probes, we investigated the relationships between the solar wind and Venus. On the basis of electron and ion current data measured in the shadow of Venus, we theoretically reproduced the data concerning the nocturnal ionosphere which could not be explained before. This took place in 1976.

Studies of Cosmic Radiation and Solar Physics

Hungarian researchers have traditionally studied the sun and the cosmic radiation. They were successful in their studies of sunspots with ground-based facilities. Accordingly, we joined the studies in a coordinated manner during the orbiting of Interkozmos satellites aimed at solar studies.

In addition to the investigation of cosmic radiation by ground-based facilities, our researchers participated in the scientific evaluation of the measured data from the Interkozmos satellites. Thus, they participated in the processing of the cosmic-radiation data measured by the Interkozmos-3 and Interkozmos-5 satellites. The Interkozmos-6 was a returning satellite, carrying aboard a so-called emulsion block in which the cosmic-radiation particles have left traces. The traces of each and every particle in the large block were evaluated after return, and the data were used to study the makeup of the radiation. Our experts also participated in this major project.

The propagation of particle radiations in the solar system was studied on the basis of measurements made by Soviet-made Progonz satellites and by the Mars-7 Mars rocket.

Lunar Material, Micrometeorite Studies

Examination of solid matter originating from outer space (material of meteorites and of planets and moons in the solar system) is very important for

obtaining knowledge of the origin and functioning of the solar system. We participated in these studies in two areas.

We participated in the analysis of some of the material brought back to earth by the Luna-16 lunar probe by employing activation analysis, a technique that has been used with success in Hungary for a long time.

In addition, we participated from the beginning in the micrometeorite studies within the framework of Soviet-Czechoslovak-Hungarian cooperation. In the course of the first experiments we used passive plastic-foil micrometeorite traps for capturing material aboard the Vertikal-1 (1970) and the Vertikal-2 (1971) geophysical research rockets, and aboard the Interkozmos-6 (1972) returning satellite.

At the same time we developed the signal-processing electronic systems for the combined Soviet-Czechoslovak micrometeorite sensors. This experiment has flown for the first time aboard the Interkozmos-12 satellite in 1974. We repeated the experiment without modifications with the Interkozmos-14 satellite in 1975, and in a modified version with the Interkozmos-17 satellite in 1977.

Tracking of Satellites for Geophysical and Geodetic Purposes

This study, as well as its direct practical utilization has a long tradition in Hungary and also in socialist countries participating in the Interkozmos program. Initially, our experts used small telescopes for visual satellite tracking and processed the data obtained to evaluate the braking of the satellites with the aim of assessing the slow, large-area changes of the atmosphere. Based on the continuously improved observation techniques and on active and close international cooperation, this work has developed further. The international program called "The Atmosphere" as well as the close cooperation among researchers from the socialist countries and France created useful results.

In addition to using the optical telescopes -- which are simple but still in use today -- we use with success the Soviet-made AFU-75 cameras, the Zeiss SBG camera from the GDR, the Interkozmos LSZD laser distance meter developed jointly within the framework of the Interkozmos project, and special radio apparatus employing high-precision Doppler measurements. In 1979 we introduced the Hungarian-developed "digit-visual" satellite tracking telescope. This significantly improved the quality of these measurements.

The basic geophysical research mentioned above has been closely connected to the application activities related to geodetic research with satellites for a long time. Within the framework of this project, the researchers initially used photographic methods; later they used the combined geodetic evaluation of data obtained by means of photography, laser techniques, and Doppler techniques. We have participated in many major international programs, such as the "ISAGEX," the "Large Loop" and the "Dynamics" programs.

Space Electronics

Of course, the development and manufacture of the instruments used in the above-mentioned satellite and rocket measurements presently features this basic and presently predominating activity of the work, both in quantitative and qualitative terms. Since, however, this subject has already been discussed earlier, we shall not discuss it here. But we must make it clear that the completion of the electronic unit of the micrometeorite detector successfuly flown aboard the Interkozmos-12 was a key part in engineering terms. In addition, we created complex vibration-testing laboratories for assuring the quality of the products and for developing the mechanical designs.

In addition to this work, Hungarian engineers have participated since the planning phase of the proposal in the preparation of the Unified Telemetry System (ETMSZ) for the Interkozmos satellites. After completion of the plans, the Hungarian partner assumed the responsibility for the manufacture of the power supplies and the analog-to-digital converters of the ETMSZ. The system has passed its test successfully aboard the Interkozmos-15 satellite launched for the engineering evaluation of the ETMSZ, and operates satisfactorily aboard the Interkozmos-18 and Interkozmos-19 research satellites launched in 1978 and 1979, respectively. On the basis of the experiences gained, Hungarian engineers developed and manufactured the special power-supply units for the Interkozmos-17 satellite, carrying complex instrumentation (launched in 1977). Closely related to this work, we continued the radio-observation experiments of satellites in Hungary, and developed a number of instruments for better ground reception. We were the first within the framework of this Interkozmos program to solve the problem involving the real-time reception of the radio signals of the ETMSZ. The signals of Tiros-N were received for the first time in Europe in our country; this is an achievement closely related to the above. This achievement carries us into the field of meteorological studies since Tiros-N is one of the latest meteorological satellites.

Cosmic Meteorology

Meteorological research is of fundamental importance, especially for countries where intensive agricultural activity is going on. Because of this reason, Hungarian meteorologists have utilized the meteorological findings obtained from satellites right from the beginning, and Hungarian experts have participated in the work of the Permanent Meteorological Working Committee of Interkozmos right from the beginning. The country's needs and conditions have basically determined the participation of the Hungarian experts in the various projects. The needs and capabilities of the country determine the measuring techniques that can be used, and they also exclude the possibility of launching meteorological research rockets from the territory of the country. At the same time, however, use can be made of the measurements made by the dense ground-station network.

Meteorological projects, ranging from research to the large number of practical applications, are assigned to the National Meteorological Service. Accordingly, the cosmic meteorological activities also take place essentially within the Service or its appropriate institues.

The quick analysis of the cloud cover, which is over large areas, is a generally important requirement and, because of the special environment of the Carpathian basin, it is one of the major tasks of Hungarian cosmic meteorologists. We regularly receive the cloud pictures of the meteorological satellites, and have done so for more than 10 years. With the aid of these pictures, our experts examine the fronts passing over Western and Central Europe. The examination also extends to the general analysis of the cloud pattern. Our experts have participated in the preparation of several major Interkozmos publications. They have developed a computer method for the characterization of meteorological phenomena on the basis of data from satellite and radiosonde measurements. Successful use is being made of the satellite pictures for the synoptic analysis of the weather, and major achievements have been made concerning the intensive relationships between the sea and the atmosphere.

Based on data from satellites, continuous studies are made of the radiation balance of the atmosphere. One goal of the studies is to elucidate and quantitatively analyze the contamination of the atmosphere and, in general, the assessment of the aerosol effects. In connection with these studies it became possible to evaluate the extent to which the global atmosphere is contaminated; satellite data make this possible.

Another goal of the studies is the investigation of the radiation balance and the elucidation of its relationship to meteorological phenomena, as well as the analysis of planetary climate changes.

Based on satellite measurements utilizing the characteristics of the carbon dioxide content of the atmosphere, the experts developed suitable methods for the determination of the vertical profiles of the atmosphere's temperature, ozone, and water-vapor levels. On the basis of the results obtained, a method was developed for the determination of the overall ozone concentration. We also analyze the long-range trends of global ozone concentration changes over the northern hemisphere. We also examine the so-called "greenhouse effect" resulting from changes in the carbon dioxide content of the atmosphere, specifically any long-range increase or decrease of the average temperature of the atmosphere.

Of course, the meteorological processes of the lower atmosphere are related to phenomena taking place in the upper atmosphere. Our experts study these relationships. In this field, there is a close relationship between physical and meteorological research.

Since the start (in 1968) of the regular reception of data from meteorological satellites, continuous development work is in progress on subjects related to the reception and processing of meteorological satellite data.

Space Communications

The role of satellites in international, intercontinental, and intranational (in case of very large countries) communications soon became a key subject. Hungary has participated right from the beginning in this subject area, meaning the utilization of space projects for international communications, within the framework of the Interkozmos program. The Hungarian Postal Service and the Communications Research Institute have worked actively in appropriate projects ever since they have started.

Same as in the other participating socialist countries, space communications in Hungary are not restricted to cooperation within Interkozmos, but, since 1971, involve practical utilization activities within the framework of the Intersputnik project.

The determination of the best location of the ground stations for space communication is a difficult and weary task in a small country such as Hungary, which is densely populated. This work required primarily international and national coordination. The residential and topographic pattern of the country

created additional difficulties. Ultimately — after several years of effort — a suitable place was found for the station, and construction has already been started. The location is suitable for the foreseeable future.

Construction and outfitting of the Hungarian Intersputnik station was completed in 1977, and experimental operation has started. Since 1 January 1978, it performs the tasks assigned to it on a regular basis.

Basic Space-Communications Research

We participate ever since the beginning in basic studies related to matters of long-range space telecommunications within the framework of the Interkozmos program. The envisaged systems utilize the frequency range between 10 GHz and 30 GHz. The analysis of the effects of local conditions and meteorological factors on operation is under study since several years.

Continuous measurements are carried out on the characteristics of signals which interfere with satellite communications, partly to clarify matters related to the establishment and operation of the Intersputnik station and partly to help in solving long-range problems. Studies are underway on the conditions for uninterrupted joint operation of satellite links and other ground-based communication systems.

In our studies made for the Hungarian communications industry and research, we achieved many theoretical and practical results. Most of these results can be used not only for space communications but also in the area of conventional telecommunications.

In addition to these studies, we work not only on broadband microwave space communications — to the extent limited only by our capabilities — but also have been working for a long time on narrow-band satellite communication experiments. Most of these experiments are carried out with the aid of the so-called amateur satellites. This work is traditional in a sense since the first successful telemetric data communication was accomplished in 1965 with the aid of the Oscar-3 amateur satellite. Our participation in this work was so extensive and so successful that Hungary now has a terrestrial guidance station for amateur satellites (in this effort we cooperate with the Hungarian Defense Association), and that we also participate in the development and construction of certain on-board devices for the Amsat European amateur satellite.

Medicine and Biology

The performance of live organisms under conditions of space travel fundamentally determines the long-range potentialities and civilizational significance of space research. Witnin the framework of the Interkozmos project, we have finalized in early 1967 the first joint medical/biological research program in this area. Hungarian researchers have participated in this effort ever since its start. Our medical and biological experts participated in the medical/biological studies in all areas where their earlier work gave them the required expertise. For example, we participate on a broad basis in many fields, and the range of activities tends to expand. In general, we set up these studies in such a manner that the research projects either relate closely to clinical practice right from the beginning or have the potential of quick implementation in therapy. Thus, most of the achievements in these areas cannot be regarded as being solely the solutions of medical/biological problems or part problems, but they are simultaneously also clinical, diagnostic, or similar achievements.

The following institutions participate on an ongoing basis in the work: Semmelweis University of Medical Sciences, Debrecen University of Medical Sciences, Pecs University of Medical Sciences, Szeged University of Medical Sciences, Institute of Advanced Medical Studies, National Oncological Institute, Central Hospital of the Hungarian People's Armed Forces, National Frderick Joliot-Curie Radiation-Biological and Radiation-Health Research Institute, Central Physics Research Institute of the Hungarian Academy of Sciences, and the Microbiology Research Group and Psychological Institute of the Hungarian Academy of Sciences. In the preparation of manned space flight in Hungary, the Flight-Medical Examination and Research Institute of the Hungarian People's Armed Forces — which also contributed by the selection of cosmonaut candidates — and Medicor Works also participated.

Radiation-Biological Studies

The researchers involved work in two main directions. First, we participated in the development of personal dosimetry. Second, we investigated the effects of the absorbed dose.

In the first area, we participated in the preparation of a number of methods, spanning the range between physical methods of measurement and study of biological indicators. In cooperation with Soviet researchers, we developed a tissue-equivalent phantom representing the standard European human. The phantom, which is not differentiated in terms of internal

organs, can now be series-produced since we have already solved the problems involved. Later, we have carried out successful work aimed at the development of tissue equivalents of internal organs.

Studies aimed at the dose distribution of various types of radiation in the body are related to the foregoing theme. The results obtained with the computer-aided methods developed for this purpose give results which agree very well with results obtained in phantom measurements. Dosimetry is highly important in space flight and in the measurements described above. Hungarian experts developed thermoluminescence (TL) dosimeters (both dosimeter substances and evaluating instruments) in this project. In the course of this work we developed many TL dosimeters and evaluating instruments of increasing complexity and miniaturization. We have carried out intensive and successful work in the field of the dosimetric utilization of various new TL substances. These versions have been used with success in space research and other fields. One of the instrument-development teams was established for these studies in medicine/biology. On the basis of the relationship between personal dosimetry and computer-aided evaluation methods, a technique was created which permits the realistic evaluation of the radiation data indicated by personal dosimeters under conditions of space flight, where radiation comes from all directions.

We investigated the effect of acute, fractionated, and chronic irradiation in animal experiments. Hungarian researchers discovered a biological indicator related to the radiation dose in the urine of the animals to supplement data from various molecular-biological measurements. Thus, the way has opened up for the (approximate) determination of an unknown dose after the irradiation. The biological indicators mentioned above are related to the distribution of the absorbed dose and the regenerative capability of the body.

In studies aimed at the elucidation of radiation-caused damage, we investigate on an ongoing basis means for reducing and perhaps also preventing damages caused by radiation. Most of this work involves the examination of the role of interferon and interferon inductors; however, our experts also participate in the analysis of other radiation-protection substances.

Major advancement in the study of the complex effect of space conditions and cosmic radiation took place as a result of the Kozmos-936-Biosputnik (1977) experiment. In this project, we participated in the histological processing of some groups of the experimental animals used.

Physiological Studies and Research on the Nervous System

The manner in which the body, blood in particular, reacts to changes in the relative and absolute concentration of atmospheric oxygen is an important area of study in general medicine and space medicine. Our researchers have investigated the oxygen content of blood, any changes that can be observed, and regeneration processes.

We are studying the modelability of weightlessness research. These studies also assist in elucidating the effects of motionlessness. In the course of these studies we participated in the Kozmos-1129-Biosputnik (1979) experiment. We examine changes in the muscles and the muscle protein of experimental animals. The evaluation phase of the study is not yet completed.

Our researchers have been studying the functioning of the equilibrium system of the body, and attempt to demarcate the pathological and the normal conditions. They investigate the possible use of pharmaceuticals capable of affecting the operation of the equilibrium system during space flight. In the course of this activity they developed new methods of examination and new computer-aided methods of data evaluation. They have elucidated a relationship between the equilibrium system and cerebral activity. Our researchers also study the role of the cerebellum in motion coordination.

We also study the activities of the large brain. An important research project in this field is the relationship between the signals of the large brain and the state of the psyche, as well as of the motivational excitational level. The studies open up new vistas toward the objective elucidation of the psychic state of humans. In the framework of these studies, we examine the possible influencing of the psychic state in a systematic manner (so-called biofeedback).

Study of the Resources of the Earth

This theme, which arose with the development of space research, is highly important for the economy and the global development of human civilization. We gradually joined this activity from 1975 onward, carrying out technical development work and interpretation of data obtained from space devices. The Ministry of Agriculture and Food, the Hungarian Geodetic Service, the National Bureau of Water Affairs, the National Meteorological Service, university departments, and other institutions participate in the work. Essentially, the work in Hungary is in the stage of learning about, exploring, and initiating practical uses of the potentialities, taking into account

the small area of the country, as well as its special geological, hydrological, agricultural, and environmental conditions.

Using space photographs, we developed a useful method for the determination of the expected water level of the Danube river and its water yield, starting out from the snow conditions of the tributary area. We also study the use of space photographs to obtain better information on the geological structure, the identification of fracture lines and circular formations, and the assessment of soil quality. In 1979 we started the complex surveying of certain areas of Hungary by aerial and space means. In this work we utilize all available information from satellites and other space devices (Salyut, Meteor, Landsat, and so forth) as well as data obtained from a special target program.

Insofar as the development of instruments is concerned, we carry out intensive work on the realization of the data-acquisition system of the Interkozmos satellites, and on the solution of certain problems of the transmission of satellite resource-study data. The Satellite Data-Collection System (SSPI) started initially on board of the Interkozmos-20 (1979) satellite. The experiments are still in progress. We prepare in Hungary not only certain on-board devices but also certain devices for the automated ground facilities used in the system (such as buoys). A data-acquisition ground station and system-control facility operates in Hungary (in Budapest).

Plans

Of course, projects already started will be continued within the framework of domestic space research. We plan a major change involving the speeding up of the processing of data obtained from satellites and rockets. Continuing ongoing experiments, we plan additional studies with improved versions of ionosphere-characteristic measuring instruments. We would also like to continue the studies started in the Plazmag experiment.

In the field of meteorology, we solve the problem related to the reception of the signals of new types of meteorological satellites. This would contribute to the research work and to the improvement of the service. Similarly, we plan to develop the work in the fields of space communications, medicine/biology, and resources study. We participate in future studies on new space-communication systems. We have completed the survey of the basic tasks of resource-exploration studies in Hungary. Based on the results of this survey, intensive work has been started in important areas of the national economy, including improvements in certain data-processing and -interpreting methods. The work carried out so far in the field of medicine and

biology was made possible by biosatellites and manned space vehicles. Accordingly, we proceeded with the development of medical/biological experiments and on-board instruments. Finally, we should mention the fact that studies are underway on those possibilities of space technology which have long-range importance for the Hungarian industry.

It is our hope that we can continue and expand space research, and that experiments carried out aboard spaceships, space stations, and other space devices will open up further potentialities for research and the utilization of the results.

[Picture captions (pictures are not reproduced)]

Author's photograph

Fig. 1. The LAM-1B ionosphere-studying instrument -- which was launched aboard the Vertikal-7 geophysical research rocket -- during testing (KFKI)

Fig. 2. The LAM-1B instrument in its casing (KFKI)

Fig. 3. The Interkozmos-12 on the tip of the launch rocket. The rocket is in horizontal position in the assembly hall. The protective hood of the sensors of the satellite is being just removed. This is the last step in the assembly procedure (KFKI)

Fig. 4. The electronic unit of the improved version of the K-1-4 micrometeorite detector operating aboard Interkozmos-17 (KFKI)

Fig. 5. Special instrument for prelaunch checkout of the K-1-4 instrument (KFKI)

Fig. 6. The so-called LAM-3 microprocessor-based system operating aboard the Prognoz-7. This system processes the data measured by the sensors of the Plazmag experiment aboard the satellite in many ways (KFKI)

Fig. 7. The Hungarian-developed analog-to-digital converter of the Unified Telemetry System (BME)

Fig. 8. Hungarian-built power-supply unit for the Interkozmos satellites. Hungary coordinates the development of the power-supply units within the Interkozmos program (BME)

Fig. 9. Experimental satellite-observation station with antenna system at Budapest Technical University

Fig. 10. Picture from a modern meteorological satellite. The picture was received in Hungary with the antenna illustrated in Fig. 7. The Pestlorinc station of the National Meteorological Service receives the pictures of meteorological satellites on a regular basis

Fig. 11. A unit of the Satellite Data-Acquisition System (SSPI) in the laboratory. The system was first launched aboard Interkozmos-20

Table 1. Experiments aboard satellites and rockets with Hungarian instruments

Space vehicle: Vertikal-1 research rocket; launch date: 28 Nov 1970; general goal: geophysical research; Hungarian experiment: micrometeorite trap; participating institution: KFKI

Space vehicle: Vertikal-2 research rocket; launch date: 20 August 1971; general goal: geophysical research; Hungarian experiment: micrometeorite trap; participating institution: KFKI

Space vehicle: Interkozmos-6 satellite; launch date: 7 April 1972; general goal: study of cosmic radiation and meteorites; Hungarian experiment: micrometeorite trap; participating institution: KFKI

Space vehicle: Interkozmos-12 satellite; launch date: 31 October 1974; general goal: ionosphere research; Hungarian experiment: electronic system of the micrometeorite detector; participating institution: KFKI

Space vehicle: Interkozmos-14 satellite; launch date: 11 December 1975; general goal: ionosphere research; Hungarian experiment: electronic system of the micrometeorite detector; participating institution: KFKI

Space vehicle: Interkozmos-15 satellite; launch date: 19 June 1976; general goal: test of the Unified Telemetry System (ETMSZ); Hungarian experiment: subassemblies of the ETMSZ; participating institution: BME

Space vehicle: Kozmos-936 satellite; launch date: 3 August 1977; general goal: biological experiments; Hungarian experiment: basic pharmaceutical studies; participating institutions: Chinoin and Joliot-Curie

Space vehicle: Interkozmos-17 satellite; launch date: 24 September 1977; general goal: complex geophysical satellite and cosmic radiation; Hungarian experiment: electronic system and power supply of the micrometeorite detector; participating institutions: KFKI and BME

Space vehicle: Vertikal-2 research rocket; launch date: 25 October 1977; general goal: geophysical research; Hungarian experiment: instrument to measure ionosphere parameters; participating institution: KFKI

Space vehicle: Interkozmos-18 satellite; launch date: 24 October 1978; general goal: magnetosphere research; Hungarian experiment: ETMSZ subassemblies; participating institution: BME

Space vehicle: Prognoz-7 satellite; launch date: 30 October 1978; general goal: study of solar wind, magnetosphere, and interplanetary space; Hungarian experiment: Lam-3 (D-173-B) part of Plazmag experiment; participating institution: KFKI

Space vehicle: Vertikal-7 research rocket; launch date: 3 November 1978; general goal: geophysical research; Hungarian experiment: instrument to measure ionosphere parameters; participating institution: KFKI

Space vehicle: Interkozmos-19 satellite; launch date: 27 February 1979; general goal: ionosphere research; Hungarian experiment: ETMSZ subassemblies; participating institution: BME

Abbreviations Used:

KFKI	Central Physics Research Institute of the Hungarian Academy of Sciences
BME	Space-Research Team, Department of Microwave Communications, Budapest Technical University
Chinoin	Chinoin Pharmaceuticals and Chemical Products Factory
DOTE	Department of Pathophysiology, Debrecen University of Medical Sciences
Joliot-Curie	National "Frederic Joliot-Curie" Radiation-Biological and Radiation-Safety Research Institute

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RESULTS, EFFORTS OF HUNGARIAN SPACE MEDICINE

Budapest FINOMMECHANIKA MIKROTECHNIKA in Hungarian Vol 20 No 1, Jan 81
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[Article by Mihaly Agoston, general director of OMKDK (National Technical Library and Documentation Center). The author was affiliated with Medicor Works, as main development department head, while the medical equipment was developed there. The author was awarded the gold medal of the Merit of Labor on 6 August 1980 by the Presidential Council in recognition of his work performed in connection with the preparation of the scientific program of astronautics]

[Text] The author reviews the work related to the medical/biological program of the first joint Soviet-Hungarian space flight from the preparatory stage to successful completion.
He draws attention to the fact that the high standards governing space-experimental equipment apply not only to the special conditions prevailing in outer space but in many instances also to well-justified requirements on the ground. Accordingly, the accomplishments of astronautics and the solutions developed for space projects are very useful for experts working in other fields also. He outlines the ambitions guiding the space researchers, which ultimately contributed most to the successful accomplishments of the space projects.

Introduction

Space research today is well beyond the stage where it represented a technical spectacle; today we take development of space projects as commonplace. Occupied with our immediate problems, we seldom notice what major efforts by how big an apparatus are required to ensure the accomplishment of the

goals. We take it for granted that the conditions for life exist aboard the spaceship, that the health of the space travelers is protected, and that only major and dangerous experiments are of special interest.

As space travel develops, the life and health protection system tends to be regarded as a necessary background for the goals of the space flights. But the situation is not like this today at all. Although the currently used spaceships and space laboratories indeed provide adequate protection for the travelers' life and health, the goal of most of the experiments is to gather additional experience for establishing the biological and health prerequisites for longer travel. This is why there is occasionally a confusion in the minds of many people concerning the matter of health and space medicine in terms of terminology, accomplishments, and future goals. The "science fiction" sector of the literature often deals with space travel, and often confuses what is feasible in medical/biological or technical terms with what is not achievable. This opens up the possibility of further misunderstandings.

Insofar as the wide circles of Hungarian scientists are concerned, space research so far has meant the string of successes in recondite fields, far from fields of their individual expertise. While these successes were indeed appreciated, the scientists did not develop the attitude that they could contribute toward their "terrestrial" goals in a direct manner. Nor have there been ideas about potentialities made possible by space-medical achievements prior to the development of the possibility of a Hungarian cosmonaut being in space. The Hungarian medical-engineering industry was no better either. The matter of the development of Hungarian space-medical devices arose only after the implementation of the Interkozmos program of the CEMA countries in December 1977, specifically after a Medicor exhibition in Moscow. The potentiality was discovered also as a result of such random events as the name of this exhibition ("Medicor in the Future") showing the enterprise's latest research and development achievements in the same exhibition hall where Soviet space accomplishments were also featured. The deputy prime ministers of the USSR and Hungary who participated in the opening ceremonies mentioned the matter of cooperation in space ventures more or less as an acknowledgment of the excellence of the new Hungarian medical devices exhibited.

The Preparations

The thought of developing an instrument to measure the processing speed of the cerebral cortex came up first as a possible medical-device develompent goal for Medicor Works during 1976-1977. The realization concept

was part of those modern medical-engineering goals which were aimed at the full elucidation of the human body for diagnostic purposes. This was preceded by a method and equipment developed at Medicor during 1965, patented in many countries, which employed the so-called biological feedback and the determination of the usual physiological parameters in combination for obtaining new and significant diagnostic information about the psychic status of the person examined, as well as about the interactions between this psychic status and the physiological conditions.

Talks started in May 1978 with the appropriate Soviet partners on the initial formulation of the development plans for a Hungarian space-medical device. Reviewing the Hungarian proposals, the Soviet partners found two medical-engineering projects of interest or significance for space-medical experiments. An agreement was reached on the development of a "Reflex" instrument (to measure information-processing capability) and a "Relax" instrument (using biological feedback) by Hungarian teams. The engineering specifications and the deadlines for completion were both very stringent. In view of the fact that both instruments existed solely in our minds -- or at best some of the details of them were experimentally founded -- nobody except those promising success believed that we will be in a position to supply six units of each instrument by the end of the year (of which only seven months were left). In spite of this, we had the first experimental prototype ready by 18 September 1978 (three and a half months later) and we actually overfulfilled the agreement since we succeeded in integrating the functions of both the Reflex and the Relax instruments in a single device, thereby achieving major reduction in weight and volume. The instrument was given the name Balaton when it was first exhibited in Moscow during the month of September. The most interesting technical feature of the instrument was the use of the INTEL 8748 type microprocessor, of which the versatile programming possibilities were not even fully exploited by the fulfilment of the original specifications of the Reflex and the Relax instruments. In consultation among Soviet and Hungarian medical experts, we thus were able to increase the functional capabilities of the instrument many fold. At this time we formulated the working hypothesis of the measurement of intellectual work capacity. The realization of this hypothesis permitted its incorporation in the Rabotospasobnost space-research project.

In the definition of the multiple functions of the Balaton instrument we obtained major help from the Hungarian Military Flight-Medical Examination and Research Institute which, on the basis of an agreement concluded years earlier, participated in the medical-engineering research program of Medicor, and which was the originator of the proposal for developing a method to measure the information-processing capability.

In an intensive effort, we assembled six instruments by the end of 1978, which successfully withstood the conditions of space flight in simulation tests, and passed all other tests which were designated as prerequisites for inclusion in the space-research program. The tests were completed in early 1979, and from then on the work involved the finalization of the Rabotospasobnost methodological program. In the meantime we looked forward to the launch of a Hungarian cosmonaut.

At the same time we developed the Balaton instrument, the need developed for a complex diagnostic instrument for ground-based space-medical tests, involving the last pre-launch examination and the first post-landing examination of the space travelers.

Preparation, execution, and post-evaluation of a space mission is also a joint medical, health, and experimental procedure. An important phase of this procedure is the determination of the health status before launch and after landing. The main directions of information acquisition involve the examination of the heart, the blood-circulation system, the respiratory system, the sensory system, and the psychic condition. All these examinations must be carried out very quickly, within a few minutes, and under conditions not resembling those prevailing in a conventional medical laboratory. To further complicate matters, the cosmonauts are still in their space garb, which is not conducive for medical examinations! Even the site of the examination is usually unconventional; thus, we need equipment that can be powered from the utility system and also from a battery (24 VDC).

Of course, the measured data must also be recorded at once since the role of the physician in the fast-moving events is lesser than under conventional conditions. He operates under a "time deficit" and wants to have an opportunity later to evaluate the measurements made in critical situations.

The Diagnoszt instrument, developed by Medicor on the basis of its experiences with the internationally acclaimed complex suitcase-diagnostic instrument (KTD), is intended to fulfill these complex and strict requirements. The Type KTD-11 F instrument, now already series-produced, is unique, and has been patented in several countries. Its technique and approach is an essential and novel part of the Diagnoszt. Essentially, the Diagnoszt combines the method of biological feedback with conventional methods of examination to obtain more and better information than the conventional methods for diagnostic purposes. The new possibilities also provide information concerning the physic status. In the definition of the medical requirements we obtained major help from the Hungarian Military Flight-Medical Examination and Research Institute which has examined for several

years the possible extension of the application range of the KTD devices to guide the work of its client, Medicor.

The Balaton and Diagnosst instrument projects were near completion when the Microbiological Research Group of the MTA [Hungarian Academy of Sciences] approached us with a request. They wanted to examine the performance of interferon under conditions of weightlessness, and asked us to develop the engineering equipment for these experiments.

Interferon is a body-produced protein which forms when the organism is attacked by viruses and bacteria, meaning under the influence of external inductors. It is one of the most highly active biological substances found in nature, and even one billionth of a milligram of it can potentially protect the animal or human cell from viral infection. It is also highly effective against the growth of normal and tumor cells. They wanted to find out in space experiments the effects of weightlessness on the induction of interferon. The Interferon I instrument was developed in response to this need; it permits the triggering of interferon synthesis in human white blood cell cultures. The Interferon II instrument contains various human interferon pharmaceutical formulations and inductor substances. The changes in the effect mechanism caused by weightlessness are examined in both instruments after landing from the space mission.

The Rabotospasobnost (Working Ability) Experiment

In the course of the development of the Balaton instrument, Medicor Works and the Hungarian Military Flight-Medical Examination and Research Institute jointly developed a method of examination which, analogously to the measurement of physical work, measures both the intellectual work capability and performance. The experiment aimed at the confirmation of the working hypothesis involved was named Rabotospasobnost (Working Ability). It is important from two points of view:

- Attempts to measure intellectual working ability in this manner are novel, even under terrestrial conditions.

- There has been no attempt in space-medical experiments so far for such measurements, and the new instrument of the experiment would assess their potential.

A major goal of the experiment is to compare the measured information on the cosmonauts under ground and space conditions with the aim of determining the effect of the space conditions on the intellectual working ability.

Since the instrument is small (it fits into the palm of the cosmonaut), weighs little (420 grams), and requires minimum energy, and has other favorable parameters, it meets the specifications for on-board instruments on spaceships and space stations.

Basically, the Balaton is a simple, four-choice reaction-time measuring instrument, which also measures the galvanic resistance of the skin and the pulse count, capable of operating in various modes.

The methodology employed permits the expression of intellectual work in mathematical terms.

The cosmonaut must make decisions (recognize signals and signal shapes) as prescribed by the instrument in the quadruple-choice mode. The true information content of the signals serving as the information are measured and expressed as a function of time (in terms of bits per second) to determine the extent and speed of the decision-making (the intellectual work). The information-processing capacity and speed thus became an important and objective measure of the intellectual work. The instrument automatically performs the required computations while the information is being processed, and displays the time and result parameters after completion of the program. By using the signal shapes serving as information as active and inhibiting stimuli, the examiner can determine the mobility of the neural and psychic processes, which in term is an important criterion of the adaptability of the central nervous system.

By simultaneously measuring the cosmonaut's information-processing capacity, pulse count, and galvanic skin-reflex changes, the instrument characterizes the true intellectual performance and assesses the functional reserve of the central nervous system. The biological feedback of the instrumentally determined pulse count and galvanic skin resistance, forming part of the experiment, permits the systematic characterization of the optimum performance or the so-called relaxed state ensuring the regeneration of the nervous system (biofeedback).

The intellectual value represented by the instrument is much higher than its material cost. Patents granted in several countries protect the unique combination of the biological feedback and the physiological parameters used in the instrument. The protection covers both the technique and the principle used. Patent application has been filed for the function aimed at the measurement of the information-processing speed. The remaining functions are generally known to the extent that means are already available for them. However, they are bulky and require trained operators.

Soviet and Hungarian experts have developed the program for the experiments with the Balaton instruemt aboard Salyut-6, as well as the methods for the evaluation of the results obtained, in joint cooperation.

The data measured in the course of the experiment permitted the assessment of high-leval intellectual activity under unusual conditions, and enabled the estimation of the available and mobilizable functional reserves. In general, the instrument enables the maintenance of the working ability at a high level. Knowing the changes in his intellectual working capacity, the cosmonaut can plan the work and rest schedule more sensibly, and the distribution of the work aboard the space station can be planned in a rational manner.

Further Space-Medical Studies

The Balaton instrument performed in a highly satisfactory manner in the experimental program of the first Soviet-Hungarian space flight. The cosmonauts learned to the like the instrument while still training on the ground since they saw clearly its practical benefits. They started to carry out competitive tests and tried to find relationships and explanations for their current condition and the measured data. The opinion went around in Csillagvaros [Star City] that this is "indeed a very good orbiting medical instrument!". Praise was often heard in transmissions from the orbiting Salyut-6 space station. The pair of cosmonauts who remained at the space station learned how to use the instrument and they continue to perform tests with it. The Hungarian research cosmonaut brought back from space the log of his measurement results for detailed evaluation and analysis.

Because of the favorable experiences reported by Soviet medical experts, who requested additional Balaton instruments, a decision was made to proceed with the manufacture of these instruments at Medicor Works.

The outlines of the continuation of the already started research work have now been formulated. The engineering configuration of the instrument, the flexible progamming possibility, and other features permit quick and convenient possibilities for trying out additional new programs. These might include the determination of decision-making and acting ability in various critical situations, assessment of psychic stress levels and their emotional burden, connection of the instrument to the telemetric system to transmit its data to the ground, and the introduction of many new parameters.

As the joint studies started, the development of many other space-medical devices in addition to the Balaton instrument has also been discussed.

With. the framework of the Interkozmos cooperative project, several Hungarian medical and biological research institutions have studied matters related to space medicine for several years. The domestic projects are coordinated by the Medical and Biological Special Committee of the MTA, and experts from the Hungarian medical-engineering industry participate in the committee's work. There is thus a possibility for combined research with the aim of solving current space-medical problems, where the medical researchers can work only if they have the proper equipment available for the task involved.

Of course, the question might be asked whether -- in view of the fact that there are so many urgent health problems to be solved on the ground -- there is justification for burdening the product-development capacity of an industrial enterprise with tasks of this nature. However, these projects almost always have results which can be used in solving problems on earth. There are already some obvious uses for the use of the Balaton instrument on the ground, so that series manufacture could be justified. Already in its present form, the instrument promises to help in the aptitude testing of operators of complex and danger-prone equipment, drivers of public-transit vehicles, and so forth. Their true working capacity could be assessed. Training in the measuring program could contribute toward improved proficiency, and this has potentials in many areas ranging from sports medicine to rehabilitation of injured individuals. A separate research program is set up for these matters; it will be handled by physcians and psychologists.

Just to quote an extreme example: Even studies aimed at the elucidation of the most definitively space-related ambient condition -- weightlessness -- on the human body could be used to help in ground-based health problems. The muscle-atrophying effect created by prolonged weightlessness is related to immobilization on the ground, for example when plaster casts are used in healing a bone fracture. The similarities are sometimes so pronounced that this method is used in ground tests for the simulation of weightlessness. The usefulness of these studies for ground-based medical activities is therefore obvious.

There is a goodly number of experimental instruments aboard the Salyut-6 space laboratory, and there are also medical-engineering devices among them. On the basis of the summarization of the experimental experiences it was concluded that many of the instruments developed so far could be integrated into a multifunctional on-board space-medical instrument or instrument system. Standardization has started within the Interkozmos program to make more efficient instrument systems, making use of experiences gained

in meeting special needs (for example power supply systems) or using facilities available aboard space laboratories for other purposes (such as the life-sustaining system and telemetry channels). The Hungarian medical-engineering industry plays an increasing role in this effort within a well-coordinated program.

Some Experiences and Impressions Related to Participation in the Space Experiment

In the introduction we have outlined the conditions under which we joined the space-research activity. It was evident, and we admit it, that we had no space-research experience whatsoever when the work was started. Yet, in spite of the prior conditions as described above and in spite of the tight deadlines, our studies were eminently successful. Many thought this effort unusual, and few were confident of its success. It is also an undeniable fact that we had luck on our side. Be that as it may, we dealt with the major obstacles and succeeded within the short time that was given us. Yet, it was not luck that helped us most; it was the hard work and the fierce ambition of those who took part in the effort. There were plenty of obstacles; we practically had nothing but ambition to sustain us. Had the equipment-procurement procedure gone its usual way, there would probably be no Balaton instrument even today. There was no programming unit for the INTEL 8748 type microprocessor; thus, we had to design and build one fast. Otherwise we could not have proceeded. In almost every instance we had to devise solutions where we did not know the requirements. We had no reserve time and we had no reserve solutions. Whatever we settled on had to work. We always faced failure and loss of prestige; this hazard was greater than the chance of success and recognition. In spite of all this, we succeeded in the work which was sort of a sideline in addition to the many tasks imposed on us by the Plan.

The sole sustenance during the experiment was that we wanted to demonstrate that we can do it. When this work started, in 1978, those assigned to it were keen to use their full capability toward contributing to the success of the Hungarian cosmonaut's mission by creating a new instrument which adds to our reputation at home and abroad. This also meant that we wanted to show that development engineers in industry can also produce useful research accomplishments. Obviously, there are few such space experiments, so that it would be useful to create conditions elsewhere for this ambition to manifest itself. It appears that research and development is not highly appreciated by society, and that the obstacles and dead ends standing in the way of success often drive our experts into indifference and risk avoidance to the detriment of Hungarian technical development as a whole.

The space experiment had a very practical result for the development engineers. When attempting to meet the very strict standards of space projects, it became evident that the efforts involved are most useful in the ground use of the instruments. High reliability, low weight, small volume, most rational ergonomic design, and the "cramping" of capabilities in the instrument all represent features that make us more competitive on the international markets. It would be too much to ask that all products of Hungarian industry should meet similarly rigorous standards; however, our general quality level could be improved on the basis of our experience in space equipment development and production. At Medicor, those participating in the experiments assumed this attitude, and it is likely that it will spread. But it could be useful for those too who do not make space equipment. The desire to do so has to do with the emotional stimuli which we described before as motivators in the space experiment. Management capable of exploring and exploiting most of t[illegible]ical development reserves is what counts; we would not even nee[illegible]ore mon[illegible], all we would need is moral stimulus and better appreciation of creative effort.

[Picture captions (pictures are not reproduced)]

Author's photograph

Fig. 1. The "Balaton" instrument. The photograph shows the dimensions, the ergonomic design, the harmony of the test functions, and the controls.

Fig. 2. The KTD-11 F instrument, which formed the basis of the "Diagnoszt." The photograph was taken at the "Molodezhnaya" arctic research station operated in Antarctica, where the device underwent long-range testing. (The location can be ascertained from the background and from the embossed postal stamp of the station.)

Fig. 3. The Interferon-I instrument.

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HUNGARIAN SPACE DOSIMETER DISCUSSED

Budapest FINOMMECHANIKA MIKROTECHNIKA in Hungarian Vol , No 1, Jan 81 pp 21-23

[Article by Istvan Feher, Bela Szabo, Peter Pal Szabo, Miklos Ranky, Sandor Deme, Jeno Vagvolgyi, and Antal Csoke, Central Physics Research Institute of the MTA (Hungarian Academy of Sciences); Yo. A. Akatov, Institute of Medical and Biological Problems, Moscow. Istvan Feher was awarded the gold medal of the Merit of Labor on 6 August 1980 by the Presidential Council in recognition of his work performed in connection with the preparation of the scientific program of astronautics.]

[Text] We developed a new portable, vibration-resistant, and impact-resistant thermoluminescence dosimeter (TLD) system for the measurement of the cosmic-radiation dose aboard spacecraft. This TDL system consists of special sheath dosimeters and a new TLD measuring instrument, the Pille. The dose range that can be measured with the new TLD system is from 10 μGy to 100 mGy. The TLD instrument can also be operated from battery power. Its power consumption is approximately 5 W; its volume is 1 dm^3; its weight is 1 kg. This article describes the construction of the TL sheath dosimeter and the Pille TL measuring instrument, and presents their engineering specifications.

Introduction

One hazard of long space missions is exposure to cosmic radiation, which could create great difficulties especially if solar activity is at a maximum. A space walk involves additional risks; then, the cosmonaut is not protected by the wall of the spacecraft and is exposed to the hazards of cosmic radiation. Spacecraft is equipped with radiation-intensity gauges

to monitor radiation exposure, and the cosmonauts wear various types of personal dosimeters for evaluation after landing.

For the checkout of cosmonauts after landing, we have earlier developed several models of laboratory TLD instruments at the KFKI [Central Physics Research Laboratory] within the framework of the Interkozmos program [1,2]. These instruments were used with success on several occasions [3].

Space travel becomes much safer if the radiation exposure of the cosmonaut is measured while he is still on board of the spacecraft. So far we had no dosimeter for this purpose. Thus, we developed a small, portable on-board TLD system with which the cosmic-radiation dose can be measured during the spaceflight mission [4].

Below we describe this TLD instrument, called Pille, and the sheath dosimeter system with accessories used in conjunction with it.

The TLD system consists of a small evaluating unit, which can also be operated from battery power, and a special sheath dosimeter using $CaSO_4$:Tm powder (Fig. 1).

The TL Sheath Dosimeter

Figure 2 illustrates the construction of the sheath dosimeter. The $CaSO_4$:Tm powder, made at Budapest Technical University, is glued to the heater panel, to which the heating current is fed via glod-plated contacts. The glass sheath contains very little potassium. The "sheath" dosimeter is installed in a key-shaped holder, so that it can be easily handled under conditions of weightlessness. The holder is accommodated in a shielded capsule which can be conveniently placed and worn aboard the spacecraft. It also reduces the energy-dependence of the dosimeter. The "sheath" dosimeter has been tested under rigorous conditions (20 g vibration, 300 g impact). It withstood this exposure without any change in technical performance characteristics.

The TLD Evaluating System

Figure 3 shows the block diagram of the Pille TLD evaluating system. The TL dosimeter is placed in the light-shielded portion on the right (Fig. 4). Rotation of the dosimeter clockwise triggers an optocoupler which in turn issues a start signal to power up the control circuits, and at the same time opening the light barrier of the photoelectron multiplier. Evaluation of the dosimeter takes place according to a program determined by the control unit. After the start signal, first only the high-voltage power supply

goes on to stabilize the photoelectron multiplier. After the time required for stabilization has elapsed, the heater supply unit goes on; however, the instrument does not yet detect the light emerging from the $CaSO_4$:Tm dosimeter to exclude the low-temperature heating peak, causing forgetting (preheating). After the preheating, the control unit switches on the current-to-pulse converter for the period of peak evaluation, and it also actuates the counter (Fig. 5). The dosimeter continues to be heated (afterheating) to reduce the residual information to a minimum and to eliminate the need for further heat treatment of the dosimeter. The measured dose, in mrad, can be read for approximately five seconds on the four-decade LED display after the evaluation. Then the control unit switches off the display to reduce the power consumption of the instrument. Until the start of the next evaluation, however, the status of the counter can be called into the display with a pushbutton. Full evaluation of the dosimeter takes approximately one minute.

The following are the main technical specifications of the Pille unit:

Volume, approximately 1 dm^3; weight, approximately 1 kg; power consumption, approximately 5 W. A special vibration-resistant photoelectron multiplier tube (EMI 9824 NA), chosen for low dark current, is used in the evaluating instrument with magnetic shielding.

In the course of the climate-resistance tests we established that the sensitivity of the Pille evaluating instrument increases by eight percent if the temperature decreases by 10°C (the gain of the photoelectron multiplier is a function of temperature). The temperature-dependence of the instrument must be considered when calculating the precise dose value.

We designed a special so-called ejector box for the instrument to protect the photoelectron multiplier tube from undue mechanical impact and vibration. The ejector box reduces the mechanical stresses on the basis of the elasticity and friction principles in all three spatial directions.

We examined the extent to which the transport box protects the instrument against impact and constant sinusoidal vibration. The results of the examination are shown in Fig. 6.

Dosimetric Characteristics of the Pille TLD Evaluating Instrument

Figure 5 shows the heating diagram of the $CaSO_4$:Tm sheath dosimeter. The first peak of the heating curve causes a forgetting of approximately 10 percent during the first two hours after irradiation; however, this is

eliminated by the built-in preheating. The residual dose after readout is less than 8 percent of the measured value. The dose that can be measured is between 10 μGy to 100 mGy. Linearity is better than 5 percent. The accuracy of dosimetry is better than 5 percent at doses above 0.1 mGy. Reproducibility among individual sheath dosimeters is less than 2-3 percent in consecutive irradiations. The direction-dependence of the dosimeters is illustrated in Fig. 7. We determined the energy-dependence (Fig. 8) with the help of the National Metrology Bureau.

Summary

Until now, the dose exposure of cosmonauts could be measured only after landing. With the aid of the TLD evaluating instrument and the "sheath" dosimeter, the dose can be measured during space flight, meaning that direct and effective dosimetry can be realized aboard the space vehicle. This is especially useful during a space walk or after a solar eruption, when large doses might be encountered.

This TLD system can be used not only in space flights but also in the environmental dosimetry of nuclear power plants since the evaluating instrument, in its 12 V version, can be operated from an automobile battery also.

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[Picture captions (pictures are not reproduced)]

Photograph of Istvan Feher

Fig. 1. The Pille measuring instrument (center). It can be seen left from the Pille where the so-called ejector box, to reduce mechanical stress, is located. The Pille instrument was placed in this box during the launch of the spacecraft; wide leaf springs covered with felt absorb most of the mechanical stress. On the right of

the instrument we see the key-shaped TL sheath dosimeter, tog ether with the shielding aluminum envelope, which can be mounted to the wall or a scafander.

Fig. 2. The capsule (a) containing the TL sheath dosimeter, with the aluminum shield (b), and the TL sheath dosimeter proper (c). Glue attaches the $CaSO_4$:Tm thermoluminescent powder to the heater panel soldered into a glass envelope, which is equipped with gold-plated contacts.

Fig. 3. Block diagram of the Pille instrument. When the TL sheath is rotated clockwise, the K_2 optocoupler switch issues a start signal to the electronic circuits. As a result, the instrument automatically evaluates the TL sheath dosimeter in approximately one minute.

Fig. 4. The Pille TLD measuring instrument. On the left we see the four-digit counter displaying -- in millirads -- the value of the dose absorbed by the TL sheath dosimeter after completion of the measurement. The two LED's indicate whether the instrument is ready for measurement or whether a measurement is still in progress ("gotov" and "idet izm" LED displays). With the aid of the push-button "vuzov cifr.," the dose value in the couter can be called up.

Fig. 5. The heating diagram of the $CaSO_4$:Tm sheath dosimeter. I: preheating, II: evaluation, III: afterheating.

Fig. 6 Test diagram of the ejector box of the Pille instrument. The ejector box significantly reduces the extent of vibration and impact, thereby protecting the Pille instrument.

Fig. 7. Direction-dependence of the sheath dosimeters.

Fig. 8. Changes in the sensitivity of the $CaSO_4$:Tm sheath dosimeters as a function of the radiation energy.

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THERMOLUMINESCENCE DOSIMETER EVALUATOR

Budapest FINOMMECHANIKA MIKROTECHNIKA in Hungarian Vol 20 No 1, Jan 81
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[Article by Bela Szabo, electrical engineer, Central Physics Research Laboratory, MTA (Hungarian Academy of Sciences), Budapest]

[Text] This article describes the history of the development of the TLD 04 B, and the NHZ 203 and 204 thermoluminescence dosimeter evaluators, the principle of operation of these instruments, their major subassemblies, the overall system-engineering solution, and some experiences in operation.

1. Introduction

Earlier articles [1, 2, 3] have described in detail the properties, versatile applications, and dosimetric principles of thermoluminescence dosimeters (TLD's). The aim of this article is to describe -- stressing the engineering development aspects -- the practical means and technical methods for the evaluation of the information stored in the dosimeter. We would like to demonstrate the problems which had to be solved in the course of the development of TLD evaluators, so that an instrument results that is easy to use with each of the many TLD materials and applications.

We wish to mention the following before starting with the description of the background of the development work: Intensive TLD instrument development became a major area of endeavor at the Radiation-Protection Department of the Central Physics Research Laboratory (KFKI) approximately 10 years ago, within the framework of the Interkozmos cooperation program.

We started with the modestly sized TLD-02 (Fig. 1) and gradually developed larger instruments. In 1972, we developed the TLD-03 (Fig. 2), in 1974 the TLD-4 (Fig. 3)[4].

The TLD-04B (TC) (the supplement "TC" denoting thermoelectric heating) was the result of further technological development (Fig. 4); this instrument has fully met the needs of universality (for example replaceable drawer for each TLD sample) and the requirements of the laboratories [5, 6]. In view of the wide range of user requirements, the Radiation-Protection Department of the KFKI produced a small series of the TLD-04B instrument during 1976-1977. This enabled many domestic users to acquire the instrument [7].The Radiation-Protection Department transferred the series manufacture to the Instrument-Technology Department of the KFKI, where manufacture is in progress for years now. The products are designated NHZ 203 and NHZ 204 [8].

In the course of the development work (which often indicated the need for the development of a simple "routine" device) we acquired experience, and because of the reliable operation of the instruments we received praise. In addition, especially in view of other KFKI accomplishments in the field of space research, we succeeded in developing a thermoluminescence dosimeter (the PILLE) for use aboard spacecraft. However, this should be the subject of another paper.

Before discussing the development approaches, let us briefly review the principle and properties of thermoluminescence dosimetry.

2. The Principle of TL Dosimeters

Certain so-called thermoluminescent (TL) materials store energy upon exposure to ionizing radiation -- α; β; γ; -- in proportion to the radiation dose. When subsequently heated (200-400°C), they release this energy in the form of light. The relationship between the absorbed energy or dose and the amount of emitted light pertains in these materials over a range of several orders of magnitude. The TL material achieves the null state upon heating, and is then reusable. The mechanism of the TL process is (presumably) as follows (Fig. 5): The electrons in the valence band become excited upon exposure to the radiation, they assume a higher-energy state and are ultimately captured in traps within the forbidden band. Upon heating, the vibration of the atoms intensifies, the electrons captured in the traps "jump out" and return to the lower-energy state, therupon repeasing the energy absorbed earlies in the form of light.

Accordingly, the function of the thermoluminescence dosimeter (TD) evaluator is the heating of the TLD materials and the measurement of the emitted light. Figure 6 shows the glow diagram of an irradiated TLD material being heated up twice in a row. It can be seen clearly that the light intensity has a peak during the first heating, which is no longer in evidence during the second heating. But it can also be seen that it makes no sense to heat the material at too high a temperature since this would cause an interfering "heat background" owing to infrared radiation.

3. Principle of the TLD Evaluator

The simplest version of the above-mentioned instrument for the evaluation of the TLD is illustrated in Fig. 7. The TLD placed on the heating tray is heated up. The light emitted as a result of heating goes into the light sensor (photoelectron multiplier tube). The current of this sensor, which is in proportion to the light, is converted into pulses by a current-to-frequency converter. The pulses are summed up by the counter. In fact, however, the matter is not quite that simple since the need for precise measurement and the variety of TLD materials require the development of more complex and versatile subassemblies.

Let us examine an evaluation method for TLD's used in real life (Fig. 8). The low-temperature portion of the light emission of irradiated TLD materials depends on the time of storage and the temperature of storage. (This is the so-called fading.) It is therefore advisable to disregard this portion during the measurement. In order to gather the entire information and to erase all information, the heating temperature should be somewhat higher than the theoretical. In this case, however, infrared radiation also forms, which should be omitted from the summation stage. The evaluation program developed in this manner is shown on the bottom curve of Fig. 8.

The TLD material is heated up uniformly and linearly. This is the $t_{heating}$ time or the T_{max} temperature sector. To ensure full heating, we maintain the TLD at T_{max} for a certain period, the $t_{heating}$ time, after which we allow it to cool by itself.

We assign the optimum light-summing sector to certain temperature values (T_{start}; T_{stop}) since these are easy-to-determine parameters. We sum up the light emerging from the TLD between these two temperatures.

The above task obviously imposes strict quality standards on the heating device, the control program, and the evaluator in general.

4. Major Subassemblies of the TLD-04B (TC) Evaluator

Heating Unit

The TLD material is heated while it is placed on the pull-out heating tray of the instrument (Fig. 9). Heating is accomplished by means of current flowing through the tray. The tray is made of stainless steel, and has an indentation in the center to hold the TLD material in the form of a tablet or powder. The direct heating current is approximately 100 A (at a voltage of approximately 1 V), which necessitates the use of a line transformer. This solution created certain technological difficulties. The temperature of the tray is monitored by a spot-welded thermocouple, of which the cold points are maintained in a miniature thermostat. The heating regulation and switching is accomplished via triacs within the primary circuit of the transformer.

Controller-Programmer

The controller-programmer (Fig. 10) monitors the signal of the thermocouple. It controls the switching of the triacs.

The 100 A peaks of the direct heating create interfering voltage on the thermocouple too. We prevent these interferences from reaching the heat-signal amplifier by ensuring that the control unit -- synchronous with the line frequency -- samples the thermocouple voltage at the zero transit of the sinusoidal signal. This is made possible by the fact that the control unit switches on the triac 1-2 msec after the zero transits.

To prevent the d.c. premagnetization of the transformer, the control unit always switches integer-period line voltage to the heating transformer.

The components setting the parameters

T_{max} - final heating temperature
$t_{heating}$ - heating-up time
t_{maint} - heat-maintenance time
T_{start} - start of light summation
T_{stop} - end of light summation

(Fig. 10) are connected to the control unit. These parameters can be seen on Fig. 8, the glow diagram.

The control unit has the following additional connections:

Inputs: Input of the thermocouple
Synchronous line input

Outputs: Start/stop of counting (in A/D) with triac heater transformer control temperature.

Light-Sensing Unit

One of the most important and delicate units in the instrument is the light-sensing photoelectron multiplier tube. Let us discuss its properties and problems briefly (Fig. 11). The light-emission spectra of some TLD materials and the so-called calibrating nuclear light source are seen at the bottom of the illustration. On the top diagram of the illustration we see the spectral sensitivity of the cathodes of some photoelectron multiplier tubes (applicable only at specific temperatures).

The effects of the already-mentioned infrared radiation are reduced with a heat-filtering glass placed between the TLD material and the photoelectron multiplier tube. Unfortunately, the photoelectron multiplier tube heats up even so, since -- it must be realized that -- we must exert temperatures of 200-400°C only a few millimeters away from the tube. We show on the next diagram (Fig. 12) what problems this heating creates durig the measurement.

The figure shows the temperature-dependence of the sensitivity of a photoelectron multiplier tube with a bialkali cathode. The vertical axis shows the changes in sensitivity, the horizontal axis shows the wavelength of the sensed light. The diagram also shows the wavelength locations of the most commonly used TLD materials and the light emitted by the calibrating light source [9].

It can be seen from the illustration that certain TLD materials and the light source emit light of such wavelength where the sensitivity of the photoelectron multiplier tube may change as much as 2.5 percent for each degree C. The change is smaller with other TLD materials, of which the light wavelength falls at a less sensitive sector.

We alleviated this serious problem by maintaining the casing of the photoelectron multiplier tube at 20°C (with an accuracy of $\pm$0.5 percent) with the aid of heating regulator operating with a Peltier element.

With a very high quality photoelectron multiplier tube (EMI 9844), the limit of the light intensity that can be measured is approximately 10^{12} lumen. Using this tube and a LiF tablet used in personal dosimetry, a dose as little as 50 μ Gy (5 mrad) can be detected. The solid-state light sensors are presently suitable to detect a light intensity of only about 10^{-9} lumen; thus, their sensitivity is approximately three orders of magnitude less than that of the photoelectron multiplier tubes. For this reason, they are seldom used at the present time.

Current-to-Frequency (A/D) Converter Unit

A current-to-frequency converter (Fig. 13) converts the current of the photoelectron multiplier tube into pulses. The following is the principle of the unit: There is a capacitor C between the input and the output of the operational amplifier E. The voltage of the output R of the amplifier E changes on the effect of the current flowing to the input M (from the photoelectron multiplier tube), while that of the input remains constant (approximately 0 V). The comparator monitors the voltage of the output R; at the given value it switches the current generator I to the input with the field-effect transistor (FET) 1. The current of this is opposite and much higher than the current to be measured, so that the output of the amplifier E soon returns to the basic level. At this time the FET 1 shuts and only the effect of the current to be measured manifests itself. The potentiometer compensating the dark current of the photoelectron multiplier tube is also connected to the input.

Above we described the current-to-frequency converter only sketchily. We should mention, for example, that the input point M covers a complex circuit that permits the lower measurement limit of the 10^{-11} coulomb digit. Also, the comparator is bidirectional too, so that the current-to-frequency converter can also process any positive overcompensation and the negative current of the photoelectron multiplier tube. The program unit gates the T_{start}/T_{stop} signal to the interval of the evaluation sector with the output pulses of the current-to-frequency converter.

The analog output Y emits a voltage which is in proportion to the light intensity, and a flip-flop circuit switches on a small lamp in the event that the current of the photoelectron multiplier tube exceeds the converting capacity of the current-to-frequency converter.

Summation, Display

Feeding the pulses to a six-decade LED display counter, we obtain the pulse count, which is in proportion to the dose, as the area below the glow curve after the end of the measurement. The content of the counter is converted into a series code for the Teletype by means of a suitable unit.

5. Description of the TLD-04B(TC) Instrument

Figure 14 illustrates the block diagram of the TLD-04B(TC) instrument.

The program for the TLD can be set with controls connected to the heating programmer and controller (Fig. 8). This unit monitors the thermocouple signal of the heating tray and regulates the heating via the heating transformer controlled by triacs. Also, it issues a voltage in proportion to the temperature at the output X.

The heating tray outlined in dotted line can be changed according to the configuration of the TLD. Nitrogen gas can be fed into the space of the heating tray to reduce oxidation flashes.

The light coming from the TLD reaches the photoelectron multiplier tube through a heat-filtering glass; the tube is accommodated in a light-shielded housing. The housing is cooled and stabilized (to 20°C) by an attached thermocouple and a heating-regulator connected to it.

A controllable high-voltage supply unit feeds the photoelectron multiplier tube. The current of the photoelectron multiplier tube -- which is in proportion to the light intensity of the TLD -- is converted by a current-to-frequency converter into pulses during the sector determined by the heating programmer and timer (Fig. 8). A voltage in proportion to the light intensity of the TLD appears at the output Y of the current-to-frequency converter.

The pulses of the current-to-frequency converter are summed by a six-digit LED display counter. The content of the counter can be transmitted to a printer/tape perforator (Teletype) via an interface unit. This enables the quick computerized processing of the data furnished by the TLD evaluator.

A special feature of the TLD-04B (TC) instrument is the digital voltmeter, which, depending on the setting of the operating-mode selector switch, shows the value of the high voltage or the temperature of the heating tray.

Of course, the instrument is also equipped with a low-voltage supply unit to feed the electronic components.

While it cannot be seen in the illustration, there is an important means for control via the nuclear calibrating light source built into the heating tray. In a certain position of the tray, this light source comes to before the photoelectron multiplier tube to permit the calibration process to be accomplished reproducibly and quickly.

Controls of the Instrument

Figure 15 is a photograph to show the TLD-04B (TC) instrument. The legends of the controls are in English, which is the language commonly used in instrument technology; thus, we dispense with their detailed explanation.

6. Measuring Experiences With the TLD-04B(TC)

Reproducibility

Reproducibility is an important quality criterion for the operating parameters of the instrument. We measured it with identical TLD substances, evaluating them after identical irradiations. Figure 16 shows the glow curves plotted in the evaluation of nine identical TLD's. The curves are superimposed, and it can be seen that they coincide so well that they seem to be a single curve.

Stability of the Instrument

An increasing number of consecutive heatings means that the instrument is increasingly stressed and that its internal temperature increases.

We examined the stability of the instrument by means of such consecutive evaluations, carried out in rapid sequence. The results are presented in Fig. 17. It can be seen clearly that the sensitivity of the instrument has changed only about -2 percent even during the most highly intensive operating cycle. This favorable result is achieved thanks to the thermoelectric cooling built into the instrument.

Description of the NHZ 203 and the NHZ 204

Finally, we describe the laboratory TLD instruments series-produced at the Instrument-Technological Department of the KFKI. In system-engineering terms, the instruments are the same as the TLD-04B (TC). The NHZ 203 has

no thermoelectric cooling; the NHZ 204 has thermoelectric cooling. In addition to featuring certain differences in mechanical design, the instruments also have some other changes. They are the following:

- Logarithmic heating curve voltage output
- Switchover possibility for automatic and manual dark-current compensation
- Switchover possibility for operating the T_{stop} during the heating or the cooling stage.

The photograph of the NHZ 203 and NHZ 204 is shown in Fig. 18. The following are the technical specifications of the instruments:

Measuring range: $5 \cdot 10^{-6}$ to 10^{3} Gy ($5 \cdot 10^{-4}$ to 10^{5} rad)
Recommended TLD materials
  $CaSO_4$:Dy powder or tablet: $5 \cdot 10^{-6}$ to 10^{2} Gy ($5 \cdot 10^{-4}$ to 10^{4} rad)
  LiF powder or tablet: $5 \cdot 10^{-5}$ to 10^{2} Gy ($5 \cdot 10^{-3}$ to 10^{4} rad)
Measuring accuracy with the recommended TLD powders: $\pm 2\%$ ± 1 digit relative to the read values
Stability: 5%/8 hrs for NHZ-203; 1%/8 hrs for NHZ-204
Operating temperature range: 15 to 30°C
Dimensions: 426 mm by 221 mm by 296 mm
Weight: 15 kg
Line voltage: 220 V
Power consumption: up to 180 VA
Heating program
  Maximum temperature: 50-500°C $\pm 2\%$, continuous
  Heating-up time: 10-90 sec $\pm 2\%$, continuous
  Heating-up speed: 2-18°C/sec $\pm 2\%$, continuous
  Heat-maintaining time: 0-40 sec $\pm 5\%$ or infinite
Measurement of light (dose):
  "Start" temperature of counter: 0-180°C $\pm 5\%$, continuous (heating-up stage)
  "Stop" temperature of counter: 0-450°C $\pm 5\%$, continuous (heating-up or cooling stage)

The sensitivity of the instrument can be continuously changed over the order of magnitude of min. three, and can be calibrated to the light source that is built in.

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[Picture captions (pictures are not reproduced)]

Fig. 1. The TLD-02 instrument and its accessories.

Fig. 2. The TLD-03 instrument.

Fig. 3. The TLD-04 instrument

Fig. 4. The TLD-04B(TC) instrument

Fig. 5. The physical principle of thermoluminescence dosimetry.

Fig. 6. Glow diagrams of an irradiated and twice consecutively heated TLD material.

Fig. 7. Principle of the TLD evaluator.

Fig. 8. Diagram of the heating program of the TLD and an evaluator.

Fig. 9. The heating circuit of the TLD-04B evaluator.

Fig. 10. Control-program unit of the TLD-04B evaluator.

Fig. 11. Light emission and sensitivity spectrum of TLD materials and photoelectron multiplier tubes.

Fig. 12. Temperature dependence of the spectral sensitivity of photoelectron multiplier tube with bialkali cathode.

Fig. 13. The current-to-frequency converter of the TLD-04B evaluator.

Fig. 14. Block diagram of the TLD-04B TLD evaluator.

Fig. 15. Front-panel and rear-panel controls of the TLD-04B evaluator.

Fig. 16. Glow diagrams of nine identical TLD's evaluated with the TLD-04B instrument.

Fig. 17. Stability diagrams of the TLD-04B(TC) evaluator.

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ROLE OF SCIENCE, TECHNOLOGY IN SOCIALIST PROGRESS

Bucharest CONTEMPORANUL in Romanian 10 Apr 81 p 5

[Article by Nicolae Ionescu, state secretary in the National Council for Science and Technology: "Science and Technology - Fundamental Components of Socialist Progress"]

[Text] Romanian and universal science and culture have enjoyed throughout the ages original achievements of great value and works by certain Romanian scholars who honored their country and their times. They founded the shining schools of mathematics, physics, chemistry, technology, geology, medicine, history, and sociology, thus raising the prestige of Romanian science and increasing the contribution of our country to the world scientific heritage.

In our times, we are dealing with a true scientific and technological revolution, a process of great scope with a profound impact in all the spheres of human activity and with a decisive role in the achievement of certain radical qualitative changes in the technical and economic structures that are bringing a powerful dynamism to all social activities and transforming production into a creative material science, while making science into a direct production force.

The importance and interdependence between the development of science, technology and the economy are clearly confirmed by the realities of our country that are based upon the profoundly scientific and new policies of the Romanian Communist Party. At the base of this policy is the concept of great theoretical and practical depth expressed by comrade Nicolae Ceausescu, the secretary general of our party, regarding the vital problems of building socialism and the profound materialist-dialectic analysis which he consistently makes regarding the continuing amplification of scientific research and the use of its results on an ever broader scale, an objective requirement that ensures the rapid progress of the society we are building.

It is known that during one period, under the influence of a dogmatic outlook regarding the future of science and technology in capitalism and the principled superiority of socialism, the importance of the scientific-technical revolution was underestimated and new, revolutionary fields of science and technology that had been affirmed throughout the world were ignored or even denied. This had considerable prejudicial effects upon general development and diminished, for a

time, the opportunity to affirm the superiority of socialism in this field, delaying reducing the gap between the developed capitalist countries and the developing socialist nations, which initially began from a relatively poor state of economic and technical development.

The Romanian Communist Party, especially after the Ninth Party Congress, undertook a critical analysis of this state of affairs, stressing that a socialist society cannot be fully affirmed as a society superior to capitalism except through the incorporation of the newest achievements of world and national science and technology into production, in the organization of work and in all other fields.

Comrade Nicolae Ceausescu pointed out: "We are living in a period of the broadest technical-scientific revolution, which is radically modifying the conditions of material production and the opportunities to put to use the natural wealth for man's benefit and which has opened giant perspectives to increase the material wealth of the world, to increase the forces of production in society and to broaden the horizon of knowledge and spiritual life for the people... Under these conditions, to underestimate the role of science, to not make sustained efforts to master its great advances and to not attempt to keep in step with the progress of the science of our century means to knowingly condemn ourselves to stagnation and backwardness, with serious reprecussions upon the development of society for a long period of time. This harms the interests of the people, the development of the nation, the independence and sovereignty of the nation and the prosperity of the country."

In the last 16 years, especially in the process of moving into the stage of building a multilaterally developed socialist society, the scientific-technical revolution as acquired ever broader dimensions, becoming one of the motive forces in the advance of Romanian society. The ever more vigorous affirmation of science in our society was possible because of the policy of the Romanian Communist Party and our socialist state, which ensured the continuing development of the material base of research activities, the training of specialists and the growth of the role of modern science and technology in all the areas of economic-social affairs.

On the basis of the decisions made by the Ninth Congress, according to which the introduction of technical progress into Romania would be done on the basis of our own scientific research and not the importation of licenses, during this period the technical-material base of science and technology increased considerably. If in 1965 the number of persons employed in research was 50,000. in 1980 it grew to over 200,000, and in 1985 it will reach 245,000. Fixed assets increased 4.5 times over in 1980 compared to 1965, and expenditures for research grew from 5 billion lei in the 1961-1965 five year plan to over 46 billion lei during the 1976-1980 period, and they will reach nearly 70 billion lei in the coming five year plan.

Concomitantly with the growth of the material base, in research there was a continuing action to improve management and the organizational structure. Today, all activity in the fields of scientific research, technological development and

the introduction of technical progress are coordinated and guided by the National Council for Science and Technology, a deliberative and broadly representative party and state organ. This council is composed of over 200 scientists - directors and general directors of institutes, academy presidents, university professors, academicians and researchers from institutes, industrial centrals and enterprises. Of special significance in the organization of the council were the decisions of the June 1979 plenary session of the National Council for Science and Technology, during which the position of Council president was entrusted to the prestigous scientist, a world renown scholar, comrade academician engineer Dr Elena Ceausescu. The naming of comrade Elena Ceausescu to this high position was for the scientists in Romania a high guarantee that all the programs in scientific research, technological development and the introduction of technical progress would be fully achieved.

Scientific research in Romania is achieved in each branch or field by institutes or centers for research and technological engineering, with the number of these throughout the country totalling nearly 200. Their activities are coordinated and guided in a unified manner by 10 central institutes and 3 academies of science. In the ministries, there are technical directorates, while in centrals and enterprises there are design offices which, paralleling research activities, have specific tasks to apply the completed scientific research to production.

During the period since the Ninth Party Congress, science and technology has acquired an important role alongside the other forces of production, and in affirming a multilaterally developed socialist society the scientists and specialists in our country have carried out an intense, efficient activity, obtaining significant achievements, including some appreciated and recognized at the international level.

In the extractive industry, Romanian scientific research produced a series of original technologies for: the use of complex mineral ores or those with a low level of useful content, the reduction of wood and metal use in mines, and the application of certain new support and exploitation technologies, as well as the processing of ores. It also introduced deep drilling, offshore drilling, a broad range of methods for the secondary recovery of in-ground crude oil and the method of extracting heavy crude by underground combustion.

Through the special achievements of the last decade and a half, the Romanian school of chemistry has been strongly affirmed on the national and international levels by the clarification and theoretical substantiation of certain phenomena and processes of great complexity: the synthesis of macromolecular products, oxidation reactions products, melted salts products, wood chemistry, natural polymers and so forth. The organic relationship between fundamental research and applied research permited the achievement of certain original technological procedures to obtain terpolymers, medicines, cosmetic products, insecticides,

fungicides, dyes, lacquers and paints, and epoxide resins. Original Romanian technology in the production of polyisoprenic rubber, an achievement with a great future in the development of industry, transportation and other branches of the national economy, also enjoys well-deserved appreciation throughout the world.

In the fields of physics and nuclear energy, technologies were created for the production of nuclear fuels and nuclear materials to be used in nuclear reactors, as well as technolgies for the preparation of radioisotopes, high-power lasers, devices, installations and equipment based on physical methods and nuclear technology for applications in industry, agriculture and medicine. Romanian contributions in magnetic resonance, nuclear physics, high-energy physics and solid physics are known and appreciated throughout the world.

In the field of machine building, scientific research has made significant achievements and is opening new perspectives in tribology, in the construction of digital-controlled machine-tools, in the latest generation computers, in precision mechanics and in the construction of technological installations and equipment of great complexity.

In electrotechny and electronics, a varied and sophisticated scientific device for control and regulation was created and the production of components began. And, to the degree in which materials will be produced in the country, micro-electronics will be intensely developed.

Our research in aerodynamics has produced important results in the fields that deal with aerodynamic profiles and the load-bearing systems of subsonic aircraft and the aerodynamics of supersonic and hypersonic airframes.

In thermotechny and thermoenergetics, research has provided valuable results with regards to the optimum burning of Romanian lignite and the use of bituminous shale for energy purposes.

In agriculture, new types of cereal grain hybrids, technical plants, vegetables and fruits were produced, as well as new technologies for raising animals. Significant efforts are being made to use in agricultural work the most improved agricultural equipment, of Romanian design and production.

In the field of medical sciences, great successes have been made in: geriatry, plastic surgery on the esophagus, virusology, normal and pathological phisiology, urology and so forth.

Important results have also been obtained by Romanian scientists in the fields of biology, mathematics, information and economic cybernetics, and in the field of scientific management and in the diverse branches of economic and social-political science.

In the 1976-1980 five year plan, activities in scientific research, technological development and the introduction of technical progress substantially contributed to the development and modernization of industry, agriculture and the other branches of the economy, and to the better use of raw materials and materials, the improvement of quality and the diversification of goods.

Special attention has been given to concentrating efforts on those projects of major importance for the national economy and for the reduction of the research-design-production cycle, and to organically integrating research and training with production. During this period, we produced over 10,300 new types of machinery, equipment, devices and installations of a highly technical and complex nature and over 5,100 new materials and consumer goods, and we applied or extended over 9,000 new and modernized technologies to production. The percentage of new and modernized products put into production during the five year plan represented 46.1 percent of the value of goods production in 1980 in the processing branches of industry, exceeding the plan provisions in this area. Increased attention was given to extending the mechanization and automation of production and to supplying the branches of the national economy with computer technology.

During this five year plan, our own scientific research provided over 90 percent of the new products and technology put into production, with special achievements being made in the machine building and chemical industries.

A broad activity was carried out in the field of standardization of products, in this way reducing the number of product types and sizes and reducing the consumption of raw materials, materials, fuels and energy, which brought about a general increase in the technical and qualitative level of production.

From the overall evaluation of activities in scientific research, technological development and the introduction of technical progress during the five year plan we just completed and through the comparison of the expenditures made involving projects of technical progress applied to national-level industry during this period with the economic results obtained by the user enterprises, during the same timeframe, the results show that for each leu spent we received an increased profit of approximately 4.50 lei. This means that the expenditures for research and technical progress projects are recouped in a period of time less than one quarter, with this being the reason for the high efficiency of the investments made in this field of activity.

The new stage in which our society has entered is increasing even more the role and importance of scientific activities, and is presenting researchers and specialists with tasks of great responsibility. They are being called upon to broaden the area of Romanian science and technology and to contribute to the acceleration of the multilateral progress of the country.

The Program-Directive for Scientific Research, Technological Development and the Introduction of Technical Progress for the 1981-1990 Period and the Principal

Directions Until the Year 2000, approved at the 12th Congress of the Romanian Communist Party, opens broad perspectives for the qualitative growth and improvement of the economy and the entire society, and clearly expresses the scientific policy of the Romanian Communist Party, according to which the newest advances of contemporary science and technology must stand at the base of all efforts to build socialism and communism in Romania.

Within a context of broad and equitable international cooperation and benefitting from the full support of society and the state, Romanian science and technology is faithfully serving development, contributing ever more to the multilateral progress of the country, to the growth of the world patrimony of knowledge and to the creation of a new economic order in a world of universal peace, prosperity and understanding.

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STATE OF GENETIC RESEARCH IN FORESTRY SECTOR DISCUSSED

Bucharest SCINTEIA in Romanian 21 Mar 81 p 3

[Interview with Dr Victor Stanescu of the Sylviculture and Forestry Exploitation Department of the University of Brasov by Ioana Dabu, place and date unknown: "Genetic Research and the Improvement of Certain Valuable Species of Trees"]

[Text] [Question] For the purpose of renewing the forestry resources of the country during the current decade, within the framework of actions to cover 400,000 to 420,000 hectares with trees and to continue to replace poorly producing stands of trees in accordance with the Program-Directive for Scientific Research, an important contribution is going to be made by forestry stock using genetically improved afforestation materials. Similarly, as was emphasized by comrade Nicolae Ceausescu at the recent Congress of the Leadership Councils of Socialist Agricultural Units and the Workers Councils in the Food Industry, Sylviculture and Water Management, there is great importance in preserving in our sylvicultural heritage those species of trees that are adapted to Romania, such as the oak, beech and so forth, limiting the percentage of resinous trees which have a tendency of spreading too much. With regards to the directions taken by Romanian scientific research in the field of genetics and the improvement of trees, I requested some clarifications from comrade professor engineer Dr Victor Stanescu of the Sylviculture and Forestry Exploitation Department of the University of Brasov.

[Answer] One task of an urgent current nature for scientific research in the field of forestry genetics is that of achieving new "types" or, better stated, new "synthetic varieties" of trees, but in no way "new species" as some people have erroneously stated, trees with a higher level of bioproduction efficiency, wood of superior quality, increased resistance to living and other types of pests and so forth.

Among the achievements made to date along these lines by Romanian research, I would point to the successful work to produce hybrids of some woody species, with the most significant success being represented by the hybrid black poplar, with a "miraculous" rate of growth of 30 cubic meters per year per hectare (under good conditions, naturally). Similarly, it should be noted that the bases were laid for obtaining genetically improved seed in seed stock orchards, some of which have already begun to produce. I am speaking especially of "orchards" of spruce, a species that for a long time has been a pet project of our researchers and

our forestry growers. On the other hand, some species that are wide spread in Romania, such as the oak and beech (which together cover over 50 percent of the forested surface area), were neglected and are, as result, currently practically unknown with regards to their genetic structure and mechanisms, and even their phenotypical variability. Such is the case of the beech.

It is useless if we introduce species that grow rapidly, but destroy the balance that nature created over thousands of years. Precisely for that reason, in order to obtain variations having solid genetic structures and that are ecologically safe we must immediately direct our research towards the improvement of the principal species of native trees. It has, therefore, become time to move without delay to the development of certain broad and systematic studies dealing with the genetics and ecological-genetics of these species, beginning with the exploration of their intraspecific variability that would show the laws of this variability and direct the selection of sources of seed, including estimating the essential genetic parameters (heritability, genetic correlations), and ending with the selection of the genetic stock for the final program regarding the reproduction of this stock in seed orchards.

[Question] Compared to agriculture, relatively modest results have been obtained in sylvicultural genetics. Beyond the specific nature of sylviculture - the long life cycle of trees, late flowering, greater difficulties in recording data because of the large dimensions - is there another reason?

[Answer] Seed "orchards," for example, cannot be listed as having genetic superiority unless prior studies were conducted to obtain the necessary substantiations for the purpose of uncovering the principal genetic parameters, such as heritability, the structure of the chromosones, the correlation between characteristics and so forth. Without these studies, the risk of obtaining varieties of trees that have merely apparently improved genetic structures is considerable. And, in Romania there are shortcomings precisely with regards to the study of basic forestry genetics, which require much, very much patience. Without this "apprenticeship," however, without a rigorous, fundamental research, complete results cannot be obtained, with profound implications in the production of vegetal biomass. Only in this manner can genetics make a positive impact upon our forests, whose percentage of coverage in our country places us only in 20th place in Europe.

Favorable perspectives for developing genetic improvement studies at the level of fundamental research can especially be found in the recent opening of a laboratory of forestry genetics within the framework of the Brasov branch of the Institute of Forestry Research and Management. In this laboratory, equipped with modern equipment at the level of the highest technology in the world in this field and with highly qualified personnel, promising fundamental research work has already been carried out. It must not be forgotten, however, for a single moment that the fate of the genetic researcher is one of a long struggle, especially with woody species. But, forestry genetics will be able to implement so-called

techniques of genetic engineering for trees, will be able to create true intergenetic hybrids, will be able to obtain the most unexpected combinations of genes to serve society precisely when genetics, this fundamental science whose laws have universal validity, takes important steps forward. In this regard, there are very encouraging perspectives. Within the framework of one contract for scientific research, which we have been working on for several years, we will develop a number of fundamental research projects regarding the conversion of biochemical energy into other forms of energy. This stems from the intention to achieve, in the end, biomass energy crops that will be used to produce biogas. For these crops, it is very important to also understand the most promising genetic structures at the bioenergy level.

Generally, we are seeking to enrich the content of practical projects along the lines of introducing certain modern laboratory analyses and carrying out certain application closely tied to the concerns of forestry production.

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